

CoronaOut: Using Risk Prediction Model and Whistle Blower platform to systematize Contact Tracing *

* Problem 4: Contact Tracing

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Abstract—In these troubled times of the COVID-19 pandemic, it has been increasingly painstaking for the government to track and trace each and every case. The solution proposed tries to take the onus to citizens by providing the service *CoronaOut*, a software solution allowing users to be aware of their vulnerability, as well as to inform to the government about the same. Each citizen will have the option to blow the whistle either on themselves or someone else they are suspecting. In this manner the necessary authorities will get hold on those cases earlier.

I. INTRODUCTION

The novel coronavirus or SARS-CoV-2 has its origin traced back to a local sea-food market in Wuhan, China. As per the current information we have, it has mostly been sourced from bats via a third carrier (mostly Pangolin). Any virus is most deadly during its **incubation period** - a period during which the virus is present in the body but the patient doesn't show any symptoms.

In the case of the novel coronavirus, we have a new challenge at hand. This particular species has a higher incubation period than common cold or influenza, claiming to have a R_0 of around 2.2^[1] or even as high as 6.5^[2]. And while the species does have a high transmission rate, what is more dangerous is its long incubation period. During which, the patient is in contact with several of his or her family members, friends and other relatives. The need of contact tracing can be understood by the example of South Korea's patient 31^[3] wherein 1 patient managed to transfer it to at least 1,500 other persons.

The virus has had a more severe impact on the old, frail or those having pre-existing conditions like heart problems, diabetes, asthma, cancer or any other chronic disease. There have been many cases of young people or those having high immune systems reportedly showing no symptoms at all before being diagnosed with SARS-CoV-2. Contact tracing ensures that these people are notified as early as possible and taken care of.

India had its first case early back in January. It was of a woman student travelling from Wuhan. Slowly cases began to

increase and it became much difficult to track each and every individual and ensure that they have followed the right quarantined procedures. The episode of Tabhligi Jamaat resulted in explosion of the virus with it gaining major foothold in the country. As many as 1,000 people were infected by March 20th, and by April 12th, India witnessed 10,000 cases with cases doubling every 4.5 days just due to the Jamaat.

In such an hour of crisis, citizens have to speak up, be aware of the surroundings and risk in their environment. Any potential case has to be informed immediately to the authorities so that necessary action may be taken. The software solution is necessary to speed up the process of contact tracing and centralise it so that the government may map out the cases. It would be especially helpful to the institutions like police which are at the fore-front of this effort. Any suspected police man or medical staff will thus be immediately quarantined.

II. LITERATURE REVIEW

First step is to have the dataset ready for *risk prediction model*. There are various one of them available online. Some of them calculate your **vulnerability index** by using factors like age, sex, country, postal code^[4] and any history of diseases^[5].

For their model, they use Logistic Regression assigning a coefficient to each factor, for example it assigns -0.14 to age, -5.49 to Intercept (direct contact with an infected), -0.212 to gender, -0.111 to Heart Disease and so on^[6]. For their dataset, they have used the summary of 72,314 cases of the outbreak in China^[7].

According to the CDC^[8], the following are at higher risk -

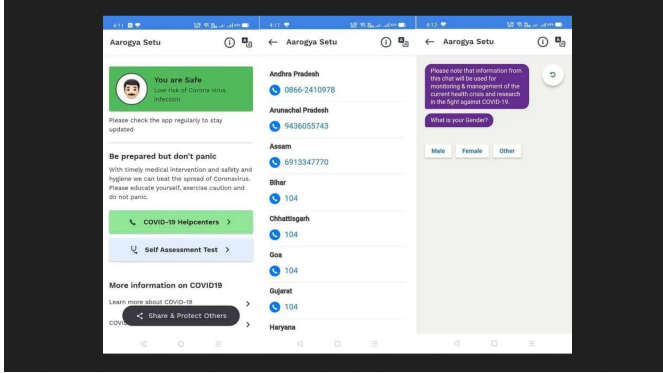
- People 65 years and older
- People who live in a nursing home or long-term care facility
- People with chronic lung disease or moderate to severe asthma
- People who have serious heart conditions
- People who are immuno-compromised
- People with severe obesity (body mass index [BMI] of 40 or higher)
- People with diabetes

Identify applicable funding agency here. If none, delete this.

- People with chronic kidney disease undergoing dialysis
- People with liver disease

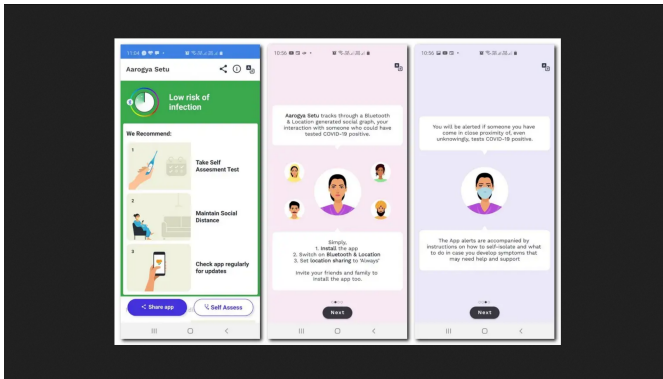
Thus one can use these parameters to train our model and identify risk associated with each person.

The Government of India is also proactive in this direction by launching the Aarogya Setu App^[9]. This app provides the means to alert the user based on his/ her symptoms and social circle. The app is loaded with a bluetooth server which constantly monitors other bluetooth devices nearby, thereby alerting the user if any positive patient is in the vicinity.



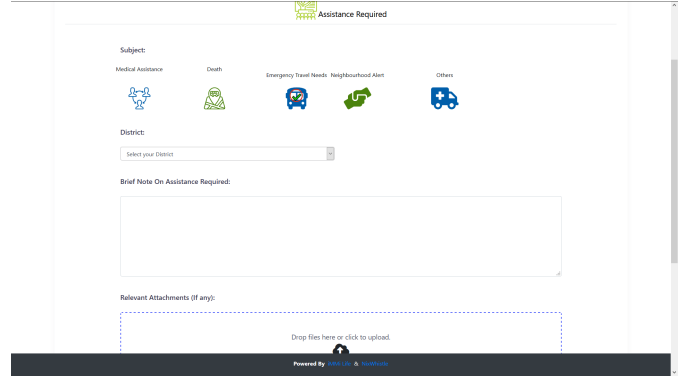
1.png

Aarogya Setu beat Pokemon Go in just 13 days^[10], with Government making office workers mandatory to install and verify if present in low risk area. However, one way in which Aarogya Setu doesn't provide the Government the full picture is the **lack** of a whistle-blower interface. As of present, the app calculates the risk to a person via their disease history, location and other nearby diseases. However if a person wants to submit information on another person or leak details of another suspect, there is no such interface.



2.png

A good example for WhistleBlower interface could be TNCoronaSpeak^[11] made specially for the Tamil Nadu Government. It allows user to submit their own case or someone else's suspected information. For each case, it has a case id through which they can track their case. This allows the government to monitor over people which normally may not follow the guidelines or are breaking the law.



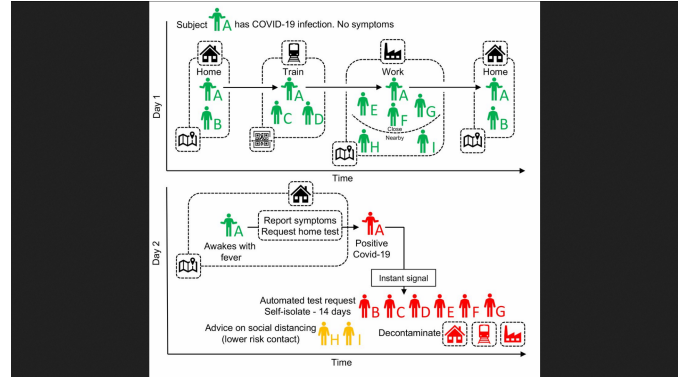
tncoronaspeak.png

If the government was informed about the Jamaat happening, it could have had taken action much earlier. As of present, there is no **official** whistle blower app by the government and all such cases of leak are punished by the mob^[12]. One way could be to protect the Whistle Blowers or to incentivise them upon giving the correct information.

According to this research^[13], it requires at least 60 % of the population to download the app in order to effectively control the virus. Digital contact tracing was explored earlier and the following formula was estimated to give a rough idea for risk prediction^[14] -

$$\beta(\tau) = P_a x_a \beta_s(\tau) + (1 - P_a)[1 - s(\tau)]\beta_s(\tau) + (1 - P_a)s(\tau)\beta_s(\tau) + \int_{l=0}^{\tau} \beta_s(\tau - l)E(l)dl$$

where $\beta_s(\tau)$ is the infectiousness of an individual currently either symptomatic or pre-symptomatic, at age-of-infection τ .



spread.png

III. SYSTEM ARCHITECTURE

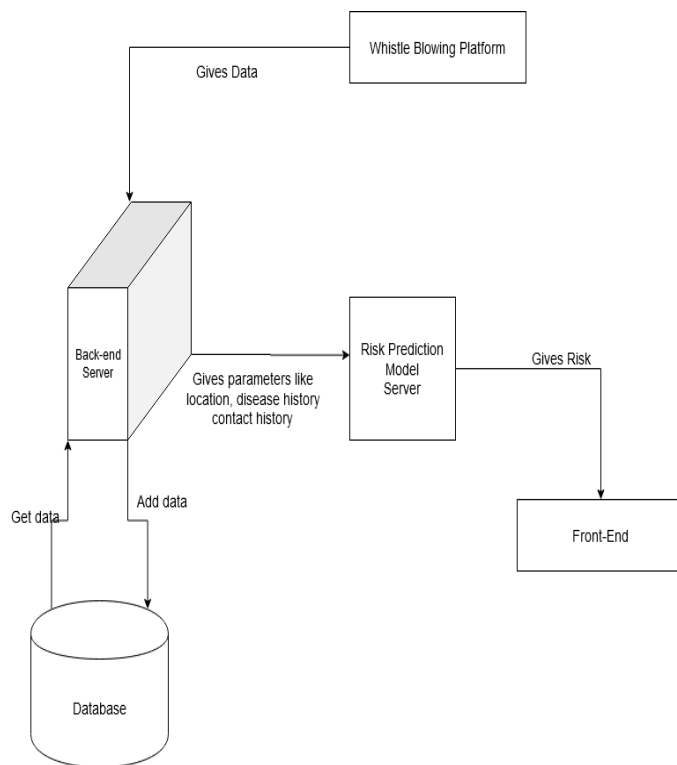
A. Preparing the architecture

The system mainly can be divided into the following modules -

- 1) Database: For each user having installed the app, an entry is created into the database with the id as his/ her Aadhaar Card. It contains columns like contact history, location, previous disease history and so on.
- 2) Risk Prediction Model Server (With parameters as per the equation).

- 3) Front-End (Mobile and Web Application): For displaying current risk factor based on personal information, it will take all the parameters from the server and predict a risk for the user. By default, there will always be a risk associated to the user even if they don't submit personal information.
- 4) Back-End Server to handle requests of users into and from the databases. Will communicate with database for queries from Risk Prediction Model or Front-End or Whistle-Blower service.
- 5) Notifier (Telegram/ Personal Message) to notify users as well as authorities, will be triggered only when getting a high risk of a particular person.
- 6) Whistle Blowing Platform (Telegram/ Messaging Bot on Website/ Helpline number) exclusively for citizens to speak up about a suspected case. Using the helpline, citizens can exclusively give info about a suspected case to government employees. And thus the government employee may manually add the data into the database upon confirming the case.

The following Architecture Diagram can be drawn with the above design -



Architectural Diagram.png

B. Listing Use Cases

Each model would contain a specific number of use-cases. A major number of use-cases have been listed. They give an idea as to how the user wants to interact with the system. Before that, a comprehensive user's profile has been given to under-

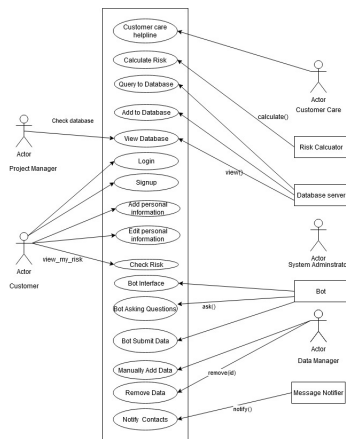
stand properly the users which are expected to use this service.

User	Mode of Usage	Level of Familiarity
Project Manager (primary)	Will manage the employees, government officials. Mostly be a high-ranking official from MoHFW	Should have a high level understanding of the solution architecture.
Data Manager (secondary)	Will look into the data provided by the customers and do the cleaning and filtering part.	Should be knowledgeable about backend queries and should be able to make sense of data
Customer Care (secondary)	Will sit on other side of the platform to receive information from the user	Should have knowledge about backend queries to add data.
System Administrator (secondary)	Will be responsible to keep the servers up and running at all times.	Should have good knowledge about systems and software.
Customer (primary)	Will process their risk level and add personal or someone else's data	Should have basic information about web surfing and mobile surfing
Database Server (secondary)	Will handle all queries at the backend and resolve all conflicts	Should be stable all the time
Medical Officials (offstage)	Will use the data to ensure all people with high risk are duly tested.	Should be able to surf the web.
Bot (secondary)	Will ask questions from user to get specific data.	Should not crash in between.
Message Notifier (secondary)	Will notify certain officials in case the risk in area gets large.	Should be able to calculate the risk in area large.

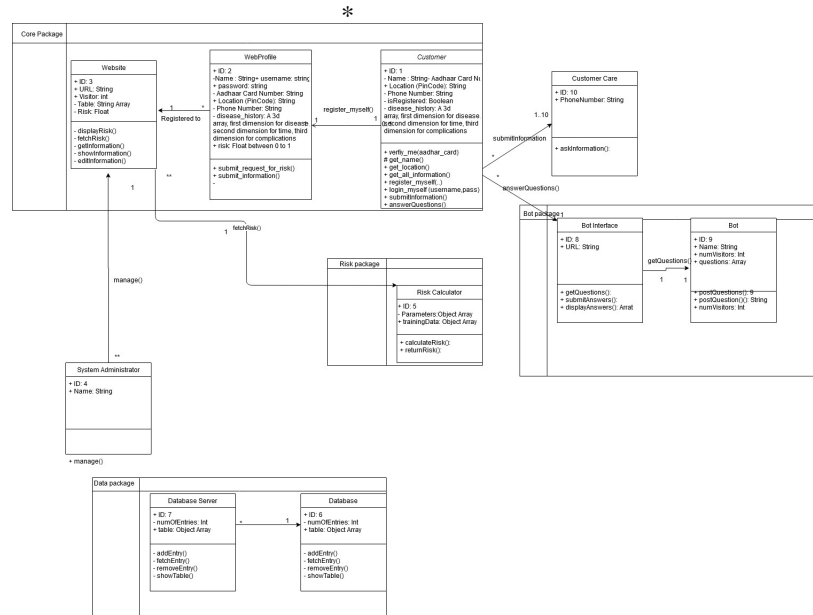
User Profile Table

No.	Use Case Name	Description
1	Signup	User should be able to successfully register himself onto the website using his/ her Aadhaar card details
2	Login	User should be able to login to the system after having successfully registered. In the case he is not, he must be redirected to the registration page.
3	Add personal information	User should be able to add personal information via interface.
4	Edit personal information	User should be able to edit personal information via interface.
5	Check Risk Option	User should have the option of risk calculation based on the information submitted
6	Bot interface	User should have the option of interacting with the bot via a chat kind of interface.
7	Bot (Asking questions from user)	The bot should be able to ask questions from the user one by one not failing once in the process.
8	Bot (Submitting data to server)	The bot should be submit the data from the user to the database not failing in the process.
9	Actual Risk calculation (black box)	The algorithm running must be able to calculate risk based on the parameters received.
10	View Database	The database should have a view option for local authorities in order to view.
11	Manually add to Database	The customer care must be able to manually add information into database.
12	Remove from Database	The data manager responsible for cleaning the data must be able to remove any faulty entries from the database.
13	Notifier	The notifier should be able to message the authorities as well as all the contacts that a particular risk levels are high for a person.
14	Customer care helpline	The user should be able to call the care at any time 24/7 and submit information about anyone suspected
15	Query Database	The database server should be able to have a query option to retrieve data
16	Add to Database	The database server should be able to add an entry to data

The following use case diagram can be drawn for the above use cases. The following use cases can be listed -



UML Use Case Diagram.jpg



UML Use Class Diagram.jpg

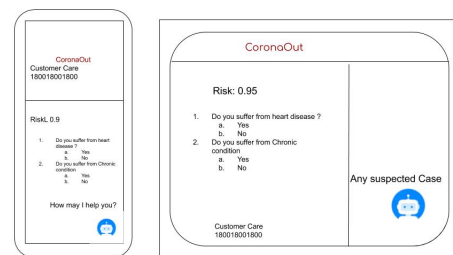
C. Enlisting Classes

The following classes can be inferred for the use cases -

No.	Class Name	Description
1	Customer	Class State: Responsible for having personal information and creating a web profile. Class behavior: Registers to website and sets isRegistered Does login to webprofile
2	Web Profile	Class State: Responsible for having login information. Class behavior: Login information stored Risk checking option available here
3	Website	Class State: Responsible for having displaying information. Class behavior: Will show risk Will show options to add information
4	System Admin	Class State: Responsible for having login information. Class behavior: Login information stored Risk checking option available here
5	Risk Calculator	Class State: Is constantly being trained on data Class behavior: When asked to get risk, returns the risk
6	Database server	Class State: Is constantly being queried for add/ delete/view Class behavior: When queried, handles the queries.
7	Database	Class State: Maintains the table of data. Class behavior: Gets the data to the server
8	Bot Interface	Class State: Responsible for asking questions to user. Class behavior: Prompts user. Submits user relevant information.
9	Bot class	Class State: Will add or send data to and from user. Class behavior: Will do it's duty when prompted
10	Customer Care	Class State: Will add from user upon asking. Class behavior: When received, will add data to db.

It could also be understood by the following class diagram -

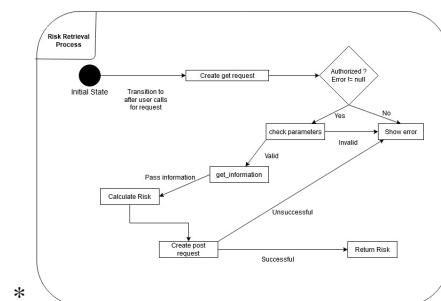
This is how the app/webapp's interface will look like -



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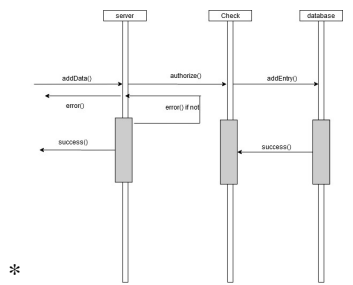
App.jpg

It can be also understood by the following sequence and state diagrams -



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UML Use State Diagram.jpg



UML Use Sequence Diagram.jpg

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D. Conclusion and Future Work

In the end, it would help us expand our community efforts to each out to all. This citizen driven effort will surely be of a big help as it would power the citizens to early eradication. By invoking the Whistle Blower's protection act, there would be immunity given to citizens^[15].

In the future, would like to make an app that automatically detects if the person would get a disease much before the disease has reached the zone. This would involve predicting disease spread model using the **genome** of the disease. This would involve efforts from all spheres like doctors etc. Hope this would reduce the need of training data.

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